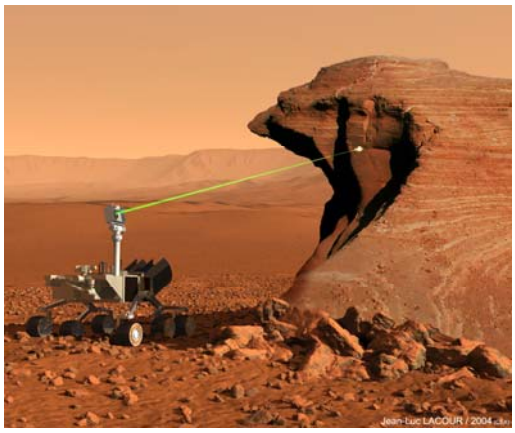
CHEMCAM

Laser-Induced Remote Sensing for Chemistry and Micro-Imaging

Roger C. Wiens, PI
Sylvestre Maurice, Deputy PI



General Description: ChemCam is being built for NASA's 2009 Mars Science Laboratory (MSL) rover. ChemCam combines laser-induced breakdown spectroscopy (LIBS) with a remote micro-imager (RMI) that provides images of the target. It provides elemental analysis of spatially resolved solid samples (<0.5 mm diameter) at distances of 1-9 m. ChemCam's primary objective is to quantitatively determine the chemical composition of rocks and regolith in order to characterize the materials in the vicinity of the rover. ChemCam's small LIBS spot size enables chemical stratigraphy of fine layers and measurement of small-scale features such as "blueberries". Since LIBS removes dust and weathering layers using multiple laser shots, contamination from Martian soils does not deter ChemCam results.

LIBS: Brief, 5 ns pulses from a 30 mJ Nd:KGW laser at 1067 nm create light-emitting plasmas from the materials ablated from the sample. The emission spectra consist of spectrally narrow atomic and first-ionized emission lines from the elements contained in the sample. ChemCam's spectral range covers 240-800 nm in 3 spectrometers with resolutions between 0.15 and 0.6 nm FWHM. LIBS detects nearly all elements, including H, C, N, O, with most elements displaying multiple emission lines. Sensitivity to alkali elements is very high, with detection limits close to 10 ppm for Li. LIBS yields major element compositions at ±10% relative accuracy and precision.

RMI: The Remote Micro-Imager provides high resolution (80 μRad) images over a 20 mRad field of view. Its primary purpose is to provide close-up context images of the LIBS analysis spots, but it can operate at any distance from 1.2 m to infinity. It will be the highest resolution long-range camera on Mars.

Operations: A typical LIBS analysis consists of 75 laser shots at 10 Hz. The 75 spectra are usually averaged together for better statistics, but can be analyzed separately, as in weathering rind analyses. A single ChemCam analysis requires only ~2 W-hr, including both LIBS and RMI. Whole rock analyses require multiple spots on the same rock. Remote depth profiling into rocks to ≥1 mm will be done with ~1000 laser shots. The recent introduction of multivariate analysis to LIBS spectra has significantly improved the accuracies and precisions as a function of SNR. The MSL operations team is planning an average of ~20 ChemCam analyses per sol, as it is used on all sol types. In addition to undertaking its own scientific investigations, ChemCam will be able to rapidly assess an outcrop and identify high priority sampling locations for the analytical laboratory instruments. The MSL Slow Motion Field Tests have elected to employ large numbers of ChemCam analyses on every sol due to its capability to provide both close-up imaging and chemical analyses while using very low resources. The ChemCam science team consists of experts in Mars geochemistry, imaging, and spectroscopy from France and the US (including from JPL, Ames, and USGS).

Management and Current Status: The PI is Dr. Roger Wiens (Los Alamos National Laboratory), who has successfully led other unique flight instruments within budget and on schedule. Los Alamos is building the Body Unit, consisting of the spectrometers and DPU. The LANL budget is $9.25M for Phases A-D, about $0.5M over its Management Plan budget. The deputy PI, Dr. Sylvestre Maurice is leading the Mast Unit, including the laser, telescope, and RMI. The Mast Unit is contributed by the French Space Agency (CNES) (Phase A-D cost of $23M) and is built by CESR in Toulouse, France. Optical fiber and electrical cables between the two units are provided by JPL. The fully functioning Engineering Model is delivered to JPL in November. The Flight Model delivery to JPL will be in May, 2008.